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AUTHOR Cherney, Elaine E.
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ABSTRACT

This document points out the numbers of students who have difficulty in their required college mathematics courses. The four common syndromes identified with pupils who were experiencing a lack of success in mathematics were: (1) a lack of an adequate college or high school background in mathematics; (2) the tendency to feel that because they completed homework problems they really "knew their mathematics,"; (3) the inability to apply appropriate reading-learning strategies to their mathematics studies; and (4) a feeling of hostility over mathematics classes and anxiety over tests. These students are referred to as "underdeveloped learners," who did not know how to study and learn mathematics. Twelve learning strategies that students should learn to apply are listed and described. A remediation strategy for these pupils that combines an understanding of problem solving strategies and problem solving is suggested. A self-instructional packet titled "Problem Solving in Mathematics" that is designed to help students develop a mind set that will enable them to have some degree of success in required math courses is described. This teacher-developed packet is based on the problem solving approach used by Whimby and Lockhead in their text "Problem Solving and Comprehension." (MP)

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Problem Solving In Math--
A Study Approach For College Students

Elaine E. Cherney

Michigan State University

If a student enters college with the desire to major in business, engineering, pre-med or other related majors, the ability to pass various levels of mathematics courses becomes a necessity of survival in the majors. For many students this need to be successful in mathematics courses, as signified by a grade of C or better, becomes a learning nightmare and a barrier to their desired goals. The numbers of students who experience academic problems with mathematics is fairly substantial. Research conducted at Michigan State University by the Office of the Assistant Provost for Undergraduate Education (1981) indicates that in 1977 the percent of students in two introductory remedial mathematics courses who received grades below a C was approximately 47%. (N= 1500) In the same courses during the fall of 1980 with an equivalent number of students the percent below a C was 33. In a regular freshman sequence mathematics course the fall of 1977 the percent falling below a C was 24. (N= 1334) In the fall of 1980 the percent below a C in the course was 36. (N= 1337)

As advisors and faculty try to help the troubled math students they will often, in frustration, urge the students to get tutor help or send them to the campus reading or skill

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support unit. It is as a reading skill support person that I have been working with these unsuccessful math students.

My work with students who were experiencing a lack of success in their mathematics courses indicated that the students seemed to share four common syndromes. These included:

1. A lack of an adequate background in math--either from high school or another college.
2. The tendency to feel that because they were able to complete the homework problems they really "knew their math."
3. The inability to apply appropriate reading-learning strategies to their math studies.
4. A feeling of hostility toward math classes and anxiety over tests.

The inadequate background in mathematics seemed to have the most negative effect on freshmen and transfer students. These students enter the university with high confidence in their academic ability and are shattered by a low or failing grade on a first or second test. These students may readily be referred to as "underdeveloped learners." They are "underdeveloped," according to McLeod (1968), in the sense that their mathematics background is inadequate enough so that they could receive only limited benefits from their instruction.

In addition to an inadequate background, these students did not know how to study and learn mathematics. Calfee (1974) suggests

that such students have unprepared minds and therefore, they cannot attend to the task nor process the knowledge. These students equate completion of homework with learning the material, thus, they are always surprised when none of the homework problems turn up on a test. The students do not seem to be able to note what Travers (1977) calls the interrelationships among the many elements in mathematical systems and that the homework problems, as Wheat (1952) states, are only illustrative exercises to show how the theory works. For these students the homework becomes the end in itself.

Of course, the overall effect of their failures and frustrations is a loss of confidence in their ability to succeed and a feeling of dislike and anxiety over mathematics.

It is important for students to recognize that it is possible to be successful in required mathematics courses by applying good learning strategies. These strategies should include:

a. They must have their time, their study strategies, their study environment and their study materials organized. A haphazard approach to math will <u>not</u> work.

b. They must review their math every day even if they do not have an assignment.

c. They must be aggressive learners - read, discuss out loud, write down.

d. They must know their course outline and the outline of the table of contents in the test. This will give

them an idea of what is being covered, where the course is going.

e. They need to understand the "big" picture.

f. When they get a text assignment skim the whole assignment first, then read the chapter carefully and ask: "What should I know when I have finished the reading, do I understand the concepts, can I work the sample questions and operationalize the concepts--do I understand the principles involved in solving the problems?"

g. They need to understand the sequence of the material; how each concept fits into the next. Math is <u>not</u> a series of disconnected events.

h. They should read ahead so that it is easier to follow the lectures.

i. When they do their homework be sure they read the directions so that they become familiar with the terminology and the concepts.

j. In addition to reviewing everyday, they should do problems every day even if there is no assignment.

k. In class write down problems that are being worked out on the board. They should see if they can figure the problems out before the instructor completes the work on the board.

l. They should keep their work; each math course builds on the theory from the course before.

In addition to good reading-study strategies it seems reasonable to assume that since unsuccessful math students, noted by Lovelace and McKnight (1980), tend to emphasize rote memory of homework problems rather than an understanding of problem-solving strategies, that the best remediation approach would be one that combined strategies and problem-solving.

Therefore, based on my own observations, a review of the literature and conversations with successful mathematics students, I began to develop materials that I hoped would be of use to unsuccessful math students. My work culminated in the development of a self-instructional packet titled "Problem-Solving In Mathematics."

The packet helps students evaluate their approach to math, interpret their feelings, provides strategies and some practice in problem solving. I have used the packet for two terms and while my sample is relatively small, approximately ten students, my success ratio is high, 100 per cent improvement.

The problem-solving approach I use in the packet is based on Whimby and Lockhead (1980). I use their book Problem-Solving and Comprehension for additional practice.

The primary purpose of the instructional packet is to help students develop a mind set that will enable them to have some degree of success in required math courses. The mind-set involves the students' recognition that to be successful in their mathematics courses they must incorporate appropriate reading-learning

and problem-solving strategies into their daily routines.

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Elaine Cherney
Learning Resources Center
Michigan State University
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PROBLEM-SOLVING IN MATHEMATICS CHECKLIST

Check the most applicable response

	Yes	No	Not Sure
1. Do you generally tend to feel positive toward taking mathematics courses?	___	___	_____
2. Have your past experiences in math courses been positive?	___	___	_____
3. Is it really necessary for you to take math courses for your major?	___	___	_____
4. Do you feel that all majors should require some advanced math courses?	___	___	_____
5. When you do your math studying, do you concern yourself with accuracy in your work?	___	___	_____
6. Do you approach your math studying in an organized way?	___	___	_____
7. Do you review your assignments every day?	___	___	_____
8. Do you work math problems every day?	___	___	_____
9. Do you notice big gaps in your math knowledge when you read or listen to lectures?	___	___	_____
10. When you are given word problems to do, do you experience a great sense of frustration as you try to work them out?	___	___	_____

SCORING THE CHECKLIST

If you answered no or not sure to questions 1, 2, 3, 5, 6, 7, 8, 9, 10, you are probably experiencing some problems in your mathematics courses.

The purpose of the learning module is to help you identify some strategies that should help you improve your standing in your math courses.

Learning Resources Center
Undergraduate University Division
Elaine Cherney 1981

Problem-Solving In Mathematics

Do word problems turn your mind blank? Does mathematics, in general, cause you to feel uncomfortable? The purpose of this unit is to help you feel more comfortable with math by showing you some problem-solving strategies. While we will not guarantee you a 4.0 in your math courses, the strategies presented here should make math more palatable.

I. Before you continue you need to understand how you "feel" toward mathematics.

a) On the line below write an "X" where you think your attitude toward mathematics is best represented.

1 2 3 4 5 6 7 8 9 10

Strongly negative toward math — neutral — Strongly positive toward math

b) Now, to see if you possess the characteristics of a successful problem solver ask yourself:

1. Do I have a positive attitude? _____
2. Am I concerned about accuracy? _____
3. Do I break problems into parts? _____
4. Do I avoid guessing or jumping to conclusions before going through all the steps? _____
5. Do I proceed in an active manner? _____

c) The answers to your attitude survey and the problem-solving characteristics may suggest reasons for problems with math. A positive attitude toward mathematics coupled with good problem solving characteristics should help move you toward success in mathematics.

d) If you feel strongly negative toward mathematics, it might help to review all your prior experiences in arithmetic and mathematics to see if your negative attitude is something you have built up over the years. Next, you need to assess why you are taking a mathematics course. If you intend to major in an area that requires mathematics, it would probably be useful to try and develop a more positive attitude.

e) To have a better understanding of what the component parts of good problem solving characteristics mean read the following:

1. Attitude: Do you give up before you really begin? Have you tried to take the problems step by step? Remember, while a problem or task may seem confusing at first, time coupled with a positive willingness to tackle the problem step by step puts you on the way toward successful study techniques.

2. Accuracy: Are you really doing what the task requires or do you zip through without careful concern for the requirements of the task?

3. Breaking Into Parts: Do you always look at the whole--do you break the steps down?

4. Guessing: Do you check your work as you move along? Do you check your reasoning process? Are you accurate?

5. Activity: Do you utilize all of you in the learning process? Do you talk aloud, write out, draw, think as well as read?

Do you understand why these five characteristics are so important? Look at the following list of strategies and note how they incorporate the five characteristics of good problem-solvers.

II. STRATEGIES FOR SURVIVING YOUR MATH CLASS

These strategies were compiled from a conversation with three successful mathematics' students who also tutor in mathematics.

a. You must have your time, your study strategies, your study environment and your study materials organized. A haphazard approach to math will <u>not</u> work.

b. You must review your math every day even if you do not have an assignment.

c. Be an aggressive learner - read, discuss out loud, write down.

d. Know your course outline and the outline of the table of contents in your text. This will give you an idea of what is being covered, where the course is going.

e. You need to understand the "big" picture.

f. When you get a text assignment skim the whole assignment first. Then read the chapter carefully and ask yourself: What should I know when I have finished the reading, do I understand the concepts, can I work the sample questions and operationalize the concepts--do I understand the principles involved in solving the problems?

g. You need to understand the sequence of the material; how each concept fits into the next. Math is <u>not</u> a series of disconnected events.

h. Read ahead so that it is easier to follow the lectures.

i. When you do your homework be sure you read the directions so that you become familiar with the terminology and the concepts.

j. In addition to reviewing everyday, you should do problems every day even if you do not have an assignment.

k. In class write down problems that are being worked out on the board. See if you can figure the problems out before the instructor completes the work on the board.

l. Keep your work; each math course builds on the theory from the course before.

III. Now, before we get to the process you need to determine whether you have the appropriate knowledge base to be successful in Math. Look at the following:

Adapted From Materials by
Judy Krupka & Charles Roberts

Math Skills OR Concepts You Should Know For Math 108

How many of these tasks can you do?

1. Graphing
2. Factoring
3. Working with Polynomials
4. Exponents
5. Logarithm (optional)
6. Functions

How many of these concepts do you know well?

7. Equations (Able to recognize and solve)
   (a) Linear equations
   (b) Quadratic equations
8. Inequalities
9. Absolute Values

You should also be able to calculate

Area - a) rectangle
b) triangle - all kinds
c) circle

Volume a) sphere
b) cube
c) cylinder
d) cone

Math Terms

Can you define all these terms:

1. Real number
   a) rational number
   b) irrational number

2. Polynominal
3. Algebraic Expression
4. Equations
5. Radical a) root
   b) power
6. Ratio
7. Proportion
8. Functions - a) domain
   b) range
9. Intercept
10. Slope
11. Variation
12. Parabola
13. Matrix

These terms are desirable ones to know:

1. Asymptote
2. Ellipse
3. Hyperbola
4. Matrix
5. Systems of Equations
6. Transformation
7. Translation
8. Substitution
9. Complex number
10. Conjugate

If, for example, you are in Math 111 and experiencing great difficulty, you do need to be sure that you have the necessary background for success. If you do not, good learning strategies will help, but you do start with a concept deficit. Make sure you are in the correct course for your background and needs.

IV. If you conclude that

One: Your skills as a problem-solver probably need improving, and

Two: You are placed in the correct mathematics course, then

you are ready for some exercises to help you develop abilities as a problem-solver.

V. Steps To Problem Solving

A. In order to problem solve there are certain steps that should be followed. One cause for word-problem crisis is the tendency to read without analysis. You need to ask yourself:

(1) What are the givens in the problem? What do I know?
(2) Next, you need to ask what do I need to know.
(3) Third, you need to decide the processes you will use in order to solve the problem.

B. Now, let's look at some sample problems.

1. A. A farmer has hens and rabbits. These animals have 50 heads and 140 feet. How many hens and how many rabbits has the farmer?

a) Note the givens -

You have hens and rabbits. You have 50 heads and 140 feet. Knowing that you have 50 heads tells you that you have 50 animals total since each animal has one head. What is your problem? -- To determine how many hens and how many rabbits the farmer has. How can I solve the problem? You know that your number of hens plus number of rabbits must equal 50 and that your hens have 2 ft. a piece and your rabbits have four feet. You, therefore, need a ratio of hens to rabbits.

25x = 2	50 ft.	
25 x 4	100 ft.	too many feet

30 x 2 =	60 ft.
20 x 4 =	80 ft.
50	140 feet

2. B. Are the two numbers $\sqrt{3} + \sqrt{11}$ and $\sqrt{5} + \sqrt{8}$ equal? If they are not, which one is larger? Find the answer without the use of the calculator.

a) What are your givens?
b) What must you decide?

(c) You have 4 numbers that are in square root. You are asked if the two sets of numbers are equal.

(d) Without a calculator or actually finding the square root of each number, you can estimate by estimating the largest square in each number.

The largest square in $\sqrt{3} = 1$

$\sqrt{11} = 3$ $\quad = 4$

$\sqrt{5} = 2$

$\sqrt{8} = 2$ $\quad = 4$

Your estimate is yes, they seem equal.

3. How can you bring exactly 6 liters of water from the river when you have only two containers, a 4-liter pail and a 9-liter pail?

   a) What are your givens?

   b) How would you solve the problem?

   c) Givens - You have 2 containers -

      one 4 liter
      one 9 liter

      You need 6 liters from the river.
      One full 4 liter plus 1/2 4 liter = 6 liters

D. The three problems are much simpler than any you have in your classes, but they do underscore the process.

   a) You must <u>first</u> determine what you know.

   b) <u>Second</u>, you have to decide what you need to know.

   c) <u>Third</u>, you have to consider and select the correct procedures that will enable you to solve your problem.

E. You need to remember that the <u>problems</u> in mathematics <u>are exercises</u> to help you <u>understand</u> the <u>processes</u>.

VI. Some Additional Aides

A. There is some research that suggests reading word problems in an if--then context facilitates the solving of the problem.

   This problem:

   In driving from town A to town D, you pass through town B and then through town C. It is ten times further from A to B than from B to C, and ten times further from B to C than from C to D. If it is 1332 miles from A to D, how far is it from A to B? Draw pictures.

   Could be stated:

   <u>If</u> A,B,C are three towns you must drive through to get to D and B is 10 times further from A then C and 10 times further from C than D and the total distance A to D is 1332 miles, <u>then</u> how far is it from A to B.

You should note the if-then sequence does change your reading of the problem. It makes your givens and what you are trying to solve clearer.

B. You must also remember that math problems are exercises that give you a chance to work out processes. Many times students are able to do their homework assignments successfully without really understanding the mathematical processes they represent. Thus, an exam will be given and their grades will not reflect what the students felt they knew. If this has happened to you, the chances are excellent that you <u>really did not understand</u> why you were doing the homework assignments.

VII. To Summarize:

a) Do you feel positive toward mathematics?

b) Do you approach your studying in an active manner?

c) Are you concerned with accuracy when you do your math?

d) Do you possess the characteristics of a successful problem solver?

e) Do you check with your teacher when you don't understand a process?

f) Do you go over your tests so that you understand why you made errors?

VIII. If you think it would help you to practice problem-solving strategies, the following materials would be useful:

a) <u>Problem Solving and Comprehension</u> by Arthur Whimbey and Jack Lochhead. This book provides a series of exercises in problem solving.

b) The following exercises are available in the Learning Resources Center--204 Bessey Hall:

<u>Problem Solving Improvement</u> - Samson

<u>General Math Word Problems</u>--C-1, C-1 - Harnadek

<u>Mind Benders</u> - Harnadek